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# **INVESTIGATIONS OF TRANSVERSE ARC ARRAY LASER ACTION IN NITROGEN GAS**

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## **Abstrak**

Kebanyakan laser denyut menggunakan pengujian melintang untuk mengujakan atom atau molekul. Biasanya, sepasang elektrod digunakan untuk menghasilkan isipadu nyahcas yang besar dan selanjat. Kuasa laser dipertingkatkan dengan menambahkan isipadu dan panjang laser. untuk tujuan ini, nyahcas berbara diperlukan dan nyahcas arka dielakkan. Nyahcas berbara mempunyai suhu electron yang tidak mencukupi untuk pengepaman laser VUV atau laser sinar-x.

Nyahcas arka merupakan satu keadaan yang sesuai untuk menghasilkan laser VUV dan laser sinar-x. Jadi, satu kaedah yang baru dijelajah dalam projek ini. Kesesuaian kaedah baru ini untuk menghasilkan laser dikaji dengan menggunakan gas nitrogen. Keputusan menunjukkan laser dapat diperolehi dan disediakan dengan kaedah susunan arka.

Beberapa kajian dijalankan untuk memperolehi induktans yang rendah. Voltan dan denyutan arus dalam nyahcas arka telah dikaji. Kuasa laser dan beberapa bentuk elektrod telah dicuba dan dikaji.

Tenaga maksimum untuk system ini ialah  $1.70 \pm 0.01$  mJ pada tekanan 55mbar. Puncak denyutan arus ialah  $2.13 \pm 0.01$  kA dan ketumpatan arus dianggarkan  $4.26 \pm 0.01$  kA/cm<sup>2</sup>. FWHM denyutan optik ialah 5ns.

Kajian ini menunjukkan kaedah susunan nyahcas arka yang baru ini berjaya menghasilkan laser. Pencapaian penting dalam eksperimen ini ialah kejayaan kaedah baru ini dalam menghasilkan laser dan kuasa laser dapat dipertingkatkan tanpa batasan. Kajian mendalam diperlukan untuk menghasilkan laser VUV atau laser sinar-X baru.

## **Abstract**

In almost all pulsed gas lasers, transverse electrical discharge is employed in the excitation of the atoms or molecules. These lasers normally employ discharge across a pair of common electrodes to provide large volume and uniform glow discharge. The scaling of output power in such lasers is obtained by increasing the volume of the discharge and also the pressure of the discharge gas. For this reason, the energy coupled into the discharge channel is kept low enough to avoid arcing. Under these circumstances, the electron temperature of such uniform glow discharge is not sufficient to produce excitation of VUV or X-ray lasers.

Since VUV lasers and X-ray lasers require discharge at higher electron temperature, arc discharge becomes the most suitable candidate for pumping such short wavelength lasers. Thus, a new discharge method is developed in this project. The possibility of having laser action by transverse arc array is investigated. This new discharge concept is tested in nitrogen gas for laser action. It is shown that lasing condition can be achieved easily and also be setup easily.

Different setups have been investigated to provide the lowest circuit inductance and thus faster discharge. The voltage and current characteristics of the discharge have been studied too. Other parameters such as pressure and output power have also been studied. Various electrode profiles have been investigated to compare the output energy and discharge characteristics.

The maximum output energy for this system is  $1.70 \pm 0.01$  mJ and the optimum operating pressure is 55 mbar. The peak current measured at one of the electrodes is  $2.13 \pm 0.01$  kA and the current density is estimated to be  $4.26 \pm 0.01$  kA/cm<sup>2</sup>. A FWHM optical pulse of 5ns pulse-width has been observed.

This study shows that the new arc array discharge circuit can also lead to laser output due to its fast discharge characteristics. More importantly, it has demonstrated a new way of electrical discharge pumping of gases that can be scaled up to higher energy coupling through arc discharge. Further work is needed to scale up the input energy needed to pump gases to higher states of ionization to obtain output in the VUV and soft x-ray regions.

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